Space Weather Technical Forecast

Issued on Saturday, 21 January 2023 at 01:07 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further R1/R2 Radio Blackouts likely. Slight chance (20%) of a CME arriving at Earth on Day 3 (23 Jan) with a possibility of G1/Minor Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low through the past 24 hours, with background C-class flares, the largest was a C7 event observed at 20/2247 UTC. Two CMEs were observed on the 20th, one missing ahead, and a second, which looks like a faint halo CME in imagery. This has been analysed, and shows a possible CME arrival at Earth on Day 3 (23 Jan). However, this is low confidence and will require further analysis. No other Earth-directed CME have been observed.

Solar Wind / Geomagnetic Activity: Solar wind speeds have been mainly at background to slightly elevated levels, between 380-420km/s. Density has been below average throughout. The IMF remained moderate, peaking at 10nT. The north-south component (Bz) was also weak, with no prolonged negative deflections, fluctuating between +6/-7nT. The phi angle was predominately positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has been at Background levels throughout.

High energy electron flux (greater than 2 MeV) has been at background levels. The 24-hour integrated electron fluence stayed below the Active threshold on a downward trend, with 2.36e6 integrated pfu observed at 21/0001 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low or Moderate, with a slight chance of reaching High levels over the next four days. There are numerous regions on the disc, but the most obvious candidates for a significant flare remain AR3190 and AR3192.

Solar Wind / Geomagnetic Activity: Solar winds currently at background levels. A fast wind associated with CH68 was anticipated to connect with Earth on the 20th or early on Day 1 (21st), although there appears to be little evidence in the solar wind data from L1 and Stereo-A of this arrival.

A faint halo CME was observed in coronagraph imagery early on the 20th Jan, following a C5 flare, which originated from AR3190. This CME has been analysed and the results show a potential arrival at Earth on Day 3 (23 Jan). This is currently low confidence, with further analysis of this event required.

The large straddling filament in the southwest quadrant lifted off the disc on the 20th Jan, which produced a CME. This has been analysed and shows a likely miss ahead of Earth, but there is a slight chance of a possible glancing blow from this CME, also on Day 3 (23 Jan), which may

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combine with the aforementioned CME.

Meanwhile, a fast wind from CH69, which is currently east of the solar meridian, is anticipated to arrive at Earth on Day 3 (23 Jan), which may combine with the aforementioned CME. This feature did not appear on previous rotation, therefore, is low confidence, with persistence offering little guidance.

Geomagnetic activity is expected to be initially Quiet to Unsettled, with slight chance of Active intervals through to Day 2 (22 Jan), possibly increasing to G1/Minor Storm on Days 3 and 4 (23-24 Jan) due to potential CME arrival (low confidence).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES-16 is likely to remain at predominantly background levels, but with a slight chance of reaching S1 or greater through the period.

High energy electron flux is likely to remain at background to moderate levels for much of the period, with a possible increase later in the period, although this is dependent on the possible arrival of a CME on Day 3 (23 Jan), which may keep electrons suppressed. As such, electron fluence is likely to stay below the Active threshold for much of this period, with possibly an increasing trend.

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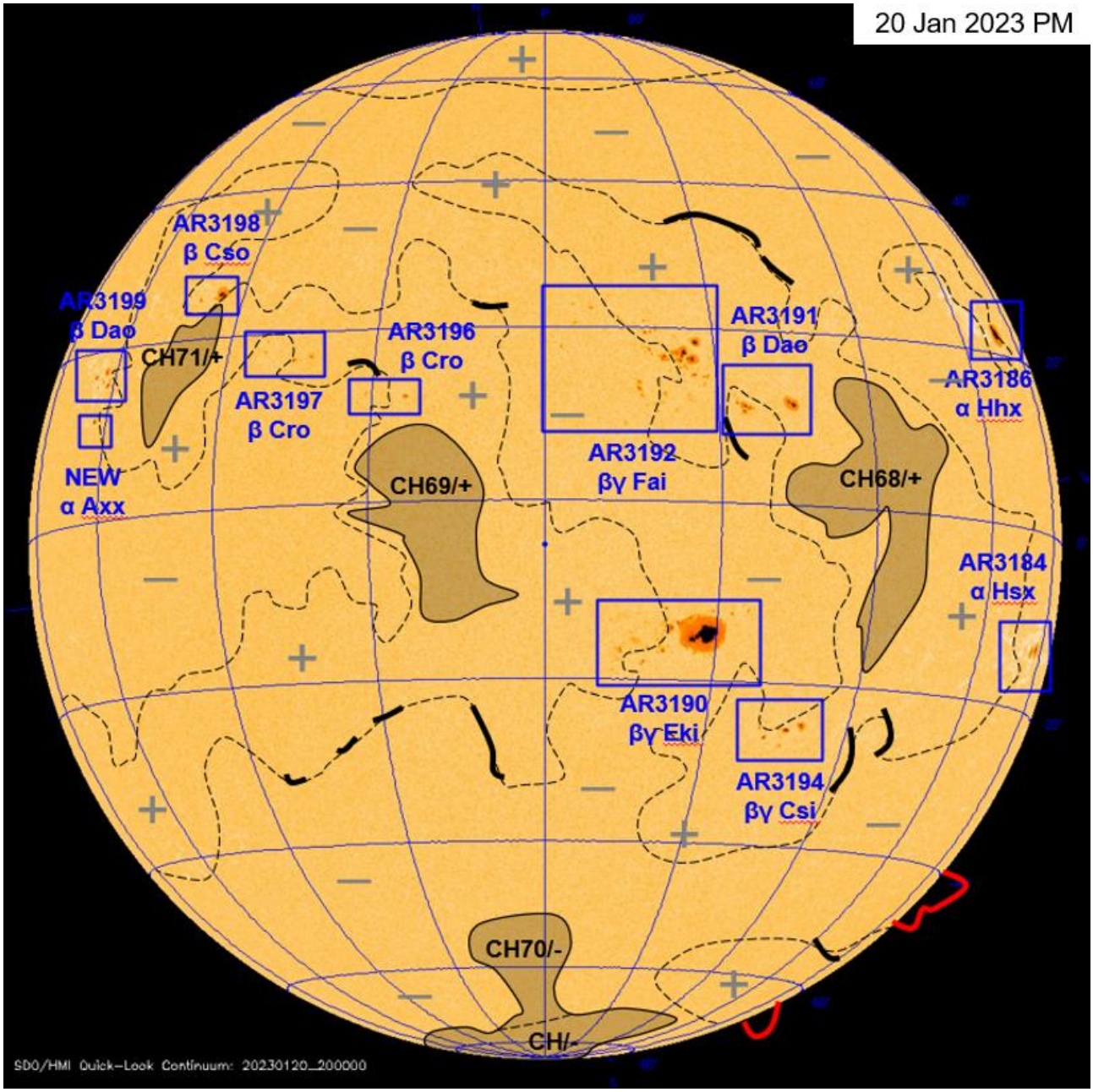
Figure 1. Solar Analysis Valid 20/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A high speed stream (HSS) associated with CH68/+ was anticipated to connect with Earth on the 20th or early on Day 1 (21st). However, there is no evidence of the HSS/CH68/+ in the solar wind data either at L1 or STEREO-A, therefore is now considered unlikely. Low confidence.

CH69/+ located just east of the solar meridian is likely to connect with Earth around Day 3 (23 Jan), although this feature did not appear on previous rotation, therefore, persistence isn't a good guidance. A combination of a potential CME arrival and a HSS on Day 3 (23 Jan) will increase geomagnetic activity to Unsettled to Active intervals, with a slight chance (20%) of G1/Minor Storms. This is low confidence, with further analysis of the CME (from 20 Jan) currently on-going.

No other Earth-directed CMEs are in the forecast.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	20	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/0920	Full	Filament Eruption	NE	530 km/s	23/0000 UTC	Low confidence

Figure 2: Possible faint halo CME from the 20th Jan.

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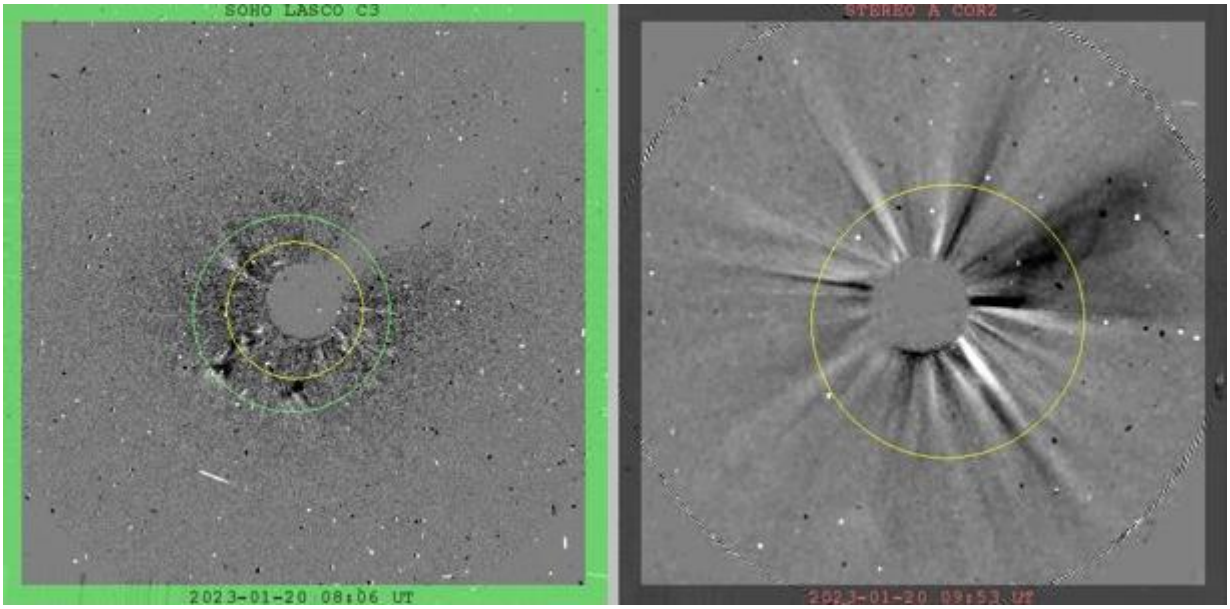
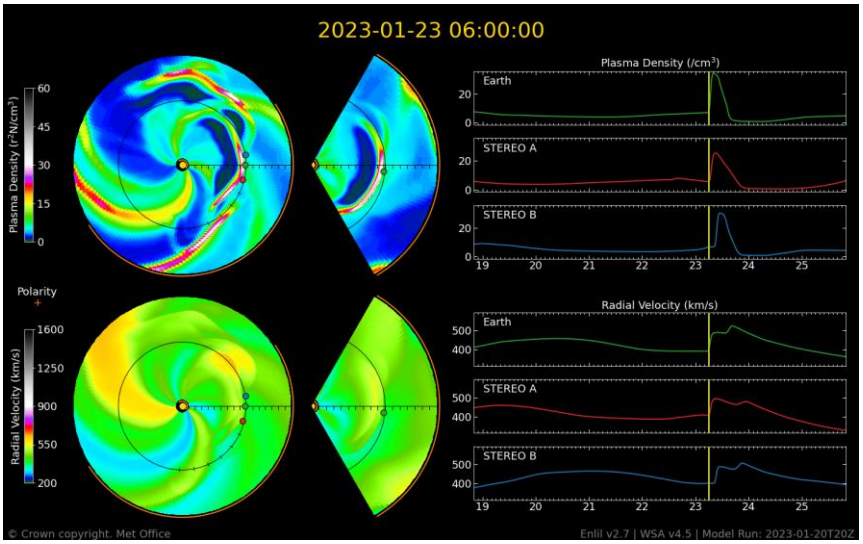
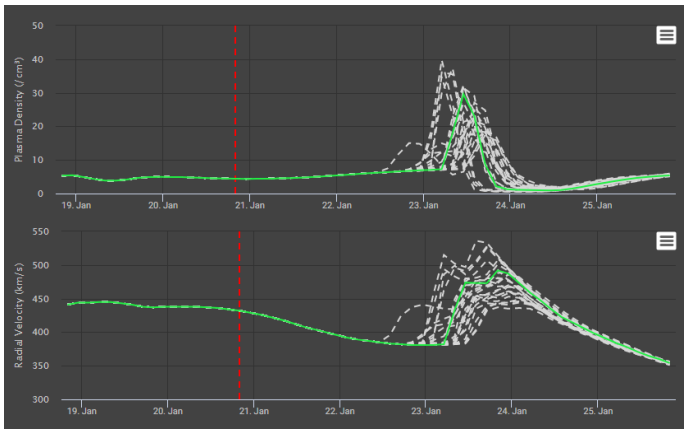


Figure 3: MOSWOC ENLIL (top) and Ensemble (bottom) – shows potential arrival of CME (shown above) on Day 3 (23 Jan). Currently low confidence, with further analysis on-going at present.





Radio Blackouts - X-Ray Flares:

Solar activity has been Low through the past 24 hours, with several C-class flares observed. The

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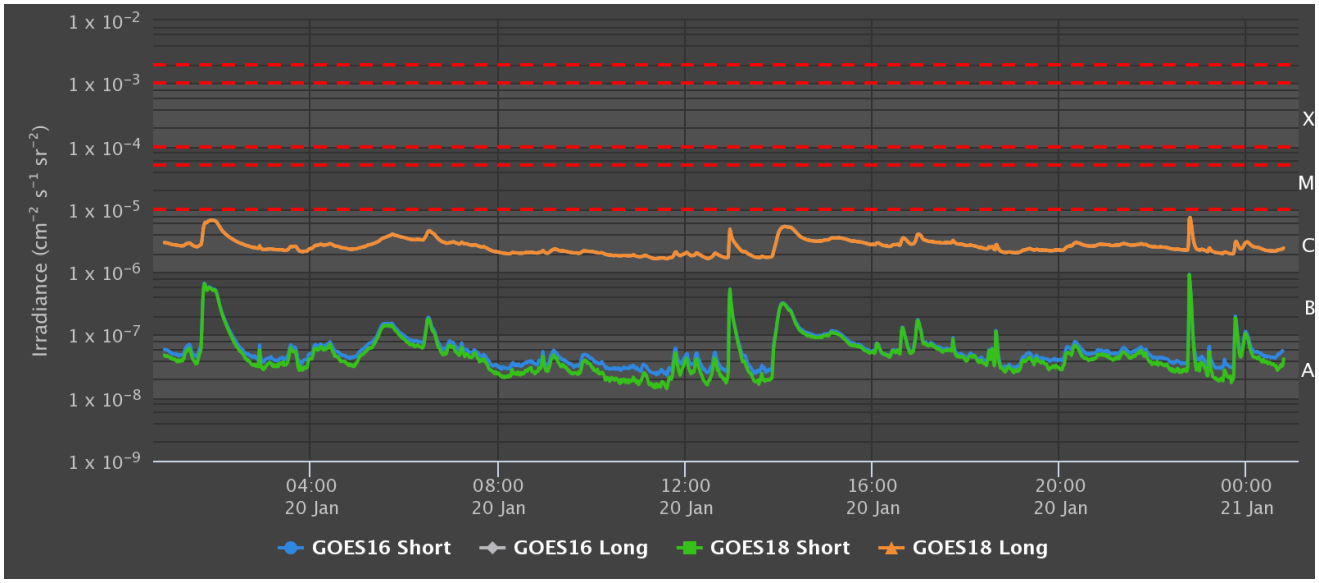
largest was a C7 flare observed at 20/2246 UTC.

Solar activity is expected to be Low to Moderate, with a slight chance of reaching High levels throughout as the most complex regions continue to rotate west.

There are ten numbered and one un-numbered sunspot regions on the visible disc. AR3190 remains the largest and most complex. AR3192 retains numerous spots and significant magnetic complexity, but the delta configuration has now decayed to a simpler beta-gamma. Other regions are smaller and appear mostly stable. The newly numbered AR3199 in the northeast quadrant has shown recent growth and is now classified as a Dao/Beta. A new sunspot has emerged to the south of AR3199, which is small and simple at present.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	70	70	70	70
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 4: GOES-18 X Ray Flares – mostly C-class flares observed past 24 hours.



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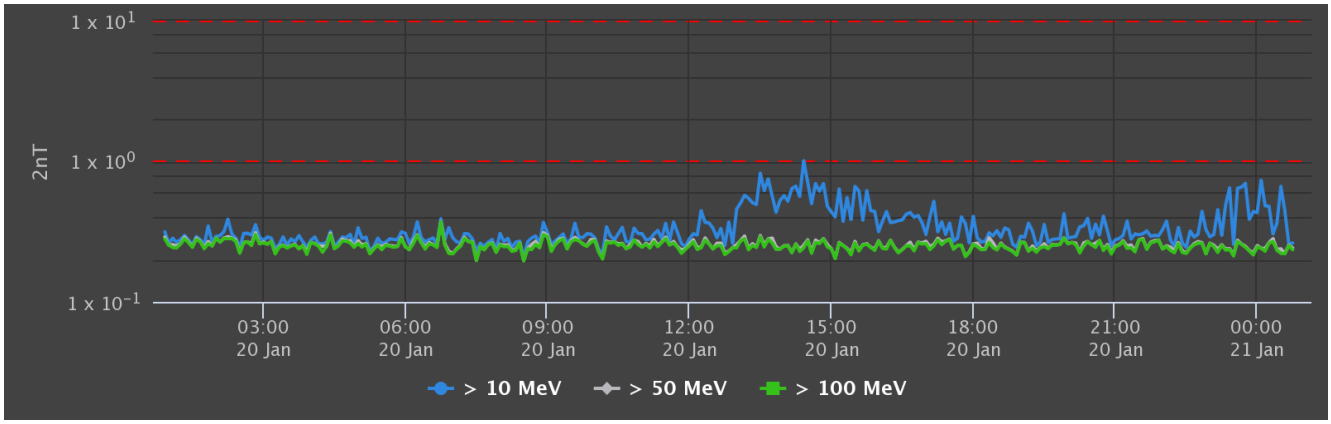
Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux is currently at background levels.

While no recent S1+ events have been observed at GEO, the sheer number of both front and far-sided complex groups dictates an elevated risk. While the relative contribution to the risk will decrease through the coming days for Ex-3182, both AR3190 and AR3192 bring an increasing risk as they rotate westwards. As such, a slight chance of S1 or greater continues through this four day period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES-16 Proton Flux – currently below the S1 level, but have been slightly elevated during the past 24 hours.



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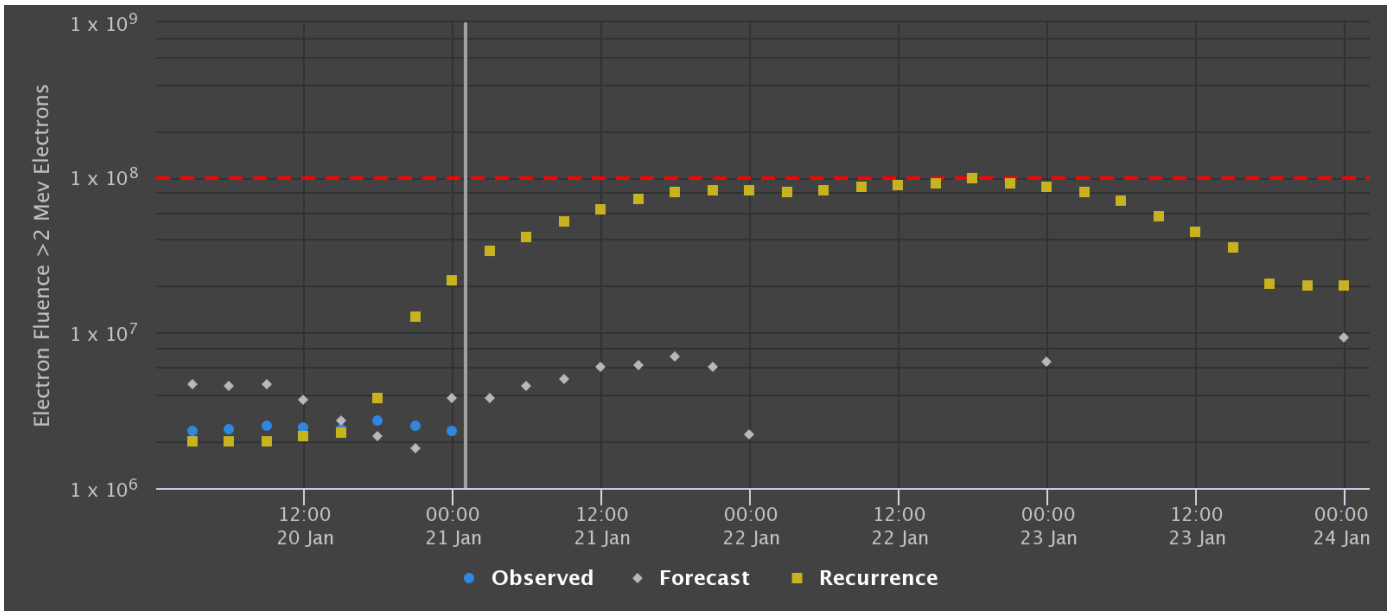
High Energy Electrons Event (≥ 2MeV):
High energy electron flux remains at background to moderate levels. Electron flux should remain at background to moderate levels, although with a slight risk of rising during the diurnal peaks in the absence of HSS from CH68/+ early on Day 1 (21st). There is currently no evidence in the solar wind data from L1 and Stereo-A for any HSS arrival. Low confidence.

Electron fluence is likely to stay below the Active threshold for much of this period. Perhaps a slight increasing trend next few days, which MOSWOC REFM is suggesting, which seems reasonable. Uncertainty in the trend by Days 3 and 4 (23-24 Jan), due to the possibility of a combined CME and HSS arriving at Earth.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	5	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 6: MOSWOC REFM and observations.



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